

The EU F-Gas regulation and the effects on environmental simulation often cause uncertainty of users and owners of test instruments. Here are some answers to the most common questions.

Links and videos:

<https://youtu.be/OdZTCsjqfNI> (EU refrigerant regulation and environmental simulation systems)

https://youtu.be/jS4YV_O9XGU (WT69)

<https://www.weiss-technik.com/en/f-gase-faq/> (information about refrigerants)

<https://www.weiss-technik.com/environmental-simulation/en/detailpages/refrigerant-wt69> (also WT77)

What is weisstechnik's position on the EU regulation of refrigerants?

We recognized the effects of the F-Gas regulation (EU) No. 517/2014 early and acted accordingly. In 2016 we were the first supplier of environmental simulation systems to offer a product - ClimeEvent - with the more environmentally friendly refrigerant R-449A (GWP 1397). Since 2018 all standard products have been converted to R-449A. In the extended temperature range down to -70°C, we have developed alternatives to R-23 with partners: WT69 / R-469A and WT77.

The EU quota system applies to all refrigerants users in Europe. **weisstechnik** has sufficient refrigerant quota for production and service. We have ensured the supply of refrigerants through long-term supply contracts, own stock and recycling.

Will there be a replacement for R-23?

Yes. **weisstechnik** uses the new refrigerant WT69 / R-469A for the temperature range down to -70°C. It replaces R-23 in our systems without any restrictions in performance. All existing test profiles can be used. WT69 / R-469A has 90 percent less global warming potential than R-23 and a GWP of 1357. Up to a filling quantity of 3.6kg, the mandatory leakage test is therefore not required. Devices with WT69 / R-469 can also be filled with R-23 in an emergency. The components used in the refrigeration circuit are identical. For older test chambers we offer retrofits to WT77.

What is the GWP and how is it calculated?

In order to be able to classify the harmfulness of the refrigerants, they are compared to the greenhouse gas CO₂. The resulting GWP value (Global Warming Potential) indicates the factor a substance adds to global warming more than CO₂. This is called the CO₂ equivalent. For example: R-404A has a GWP value of ≈ 3900. One kilogram of released R-404A corresponds to the influence of ≈ 3900 kg CO₂ in the atmosphere.

Why did the prices for refrigerants increase so much?

The EU has adopted a quota system for the total amount of fluorinated greenhouse gases produced and imported in the EU. Since 2015 the allowable amount (in terms of CO₂ equivalent) decreases every year. Right now, less than half of the quantity available in 2015 is allowed. By 2030, the allowed amount will fall to 20%, newer plans show an amount below 10%. This shortage is leading to increased prices, especially for high GWP refrigerants.

Do I have to retrofit my equipment?

All fluorinated or chlorinated refrigerants with an ODP (ozone-damaging) are no longer permitted and must be replaced. For refrigerants with a GWP >2500, stricter rules will apply from 2020. For example, in case of repair a quantity of more than 10kg R-404A may only be replaced by recycled R-404 (40t CO2 equivalent). From 2030 on, no refrigerant with GWP > 2500 may be refilled.

In the event of a repair, we convert R-404A in existing systems to R-452A, R-23 will be changed to WT77. There are only a few technical changes needed. **weisstechnik** Service advises in individual cases.

What about CO2?

CO2 is a very potent refrigerant for temperatures down to -45 °C. From -56 °C it becomes solid (snow).

For **weisstechnik**, CO2 is neither an alternative to R-449A nor to R-23, because cooling-circuit components for climatic cabinets is too costly and low temperatures cannot be reached or are not reached fast enough. For walk-in chambers, CO2 is an option because the technical effort is less significant.

At the moment there are only few standardized, tested components for CO2. Often a standstill cooling is necessary because the pressure in the system at 30 °C ambient temperature would rise to over 70 bar.

Alternatively, very large pressure-compensation tanks are needed. Heat compensation below -45 °C is very low when using CO2.

weisstechnik offers the right refrigeration system for every chamber size and every performance requirement.

Which other refrigerant alternatives are there?

The temperature range down to -70°C is perfectly covered with R-449A and R-469A / WT69. **weisstechnik** continues to conduct intensive research with partners to find alternatives to refrigerants for the temperature range down to -80°C and for conversions.

We always select the best available refrigerant for customized systems. We pay close attention to the safety and practicability of the substances. In our opinion, refrigerants must not be flammable (not even when leaking), non-toxic and non-corrosive. At the same time, plant safety must be guaranteed. High pressure, de-oiled compressors, special lubricants etc. are not an option for our standard systems.

Thus, many organic substances (ethane, etc.) are no alternative for us. The same applies to mixtures such as R1234yf, which becomes flammable in the event of leakages. Nitrous oxide (N2O) is not an alternative because of the corrosive effect and the need for special compressor oils.

weisstechnik relies on R-449A and WT69 / R-469A R-23 (for -70 °C) for standard cabinets.

For large systems and walk-in chambers, more and more cascades with R134a and CO2 are being used. The more complex technology for the CO2 cascade often pays off because of the reduced energy requirement.

Ammonia can be an alternative too.

Which rules apply to leakage tests?

Since 2017, leakage tests are mandatory and dependent on the CO2 equivalent. From 5t CO2 equivalent, an annual test is required (e.g. 1.25 kg R-404A). The period to the next leakage test can be extended by installing an automatic leak monitoring system.

The leakage test is also recommended by DIN EN 378-4. In this standard, the amount of refrigerant is relevant. From 3 kg of any refrigerant an annual test is required, from 30kg half-yearly, from 300kg quarterly.

The "permitted" leakage rate depends on the amount of refrigerant and the production date of the system.

Example: A system with up to 10 kg of refrigerant and construction after June 2008 may still lose 3% of refrigerant per year. Our systems are leak-tight.

GENERAL POINTS

1. What is the F-gas Regulation?

"The objective of this Regulations is to protect the environment by reducing emissions of fluorinated greenhouse gases (including refrigerants). Accordingly, this Regulation:

- a) establishes rules on containment, use, recovery and destruction of fluorinated greenhouse gases, and on related ancillary measures,
- b) imposes conditions on the placing on the market of specific products and equipment that contain, or whose functioning relies upon, fluorinated greenhouse gases,
- c) imposes conditions on specific uses of fluorinated greenhouse gases, and
- d) establishes quantitative limits for the placing on the market of hydrofluorocarbons."¹

2. Why are climate chamber operators affected?

Climate chambers are cooled by refrigerants which consist of hydrofluorocarbons and are thus subject to the F-gas Regulation. As an operator of such a system, you are legally obliged to implement the Regulation in a technically correct manner.

3. Which refrigerants are affected?

The Regulation contains a classification system that specifies which refrigerants must be replaced due to their potentially detrimental properties. In the case of environmental simulation systems, this predominantly refers to R-404A and R-507.

Thanks to an exemption in the field of environmental simulation, R-23, which is also used, is not affected (see 4.). R134a, which is used to some extent, is also exempted from the Regulation.

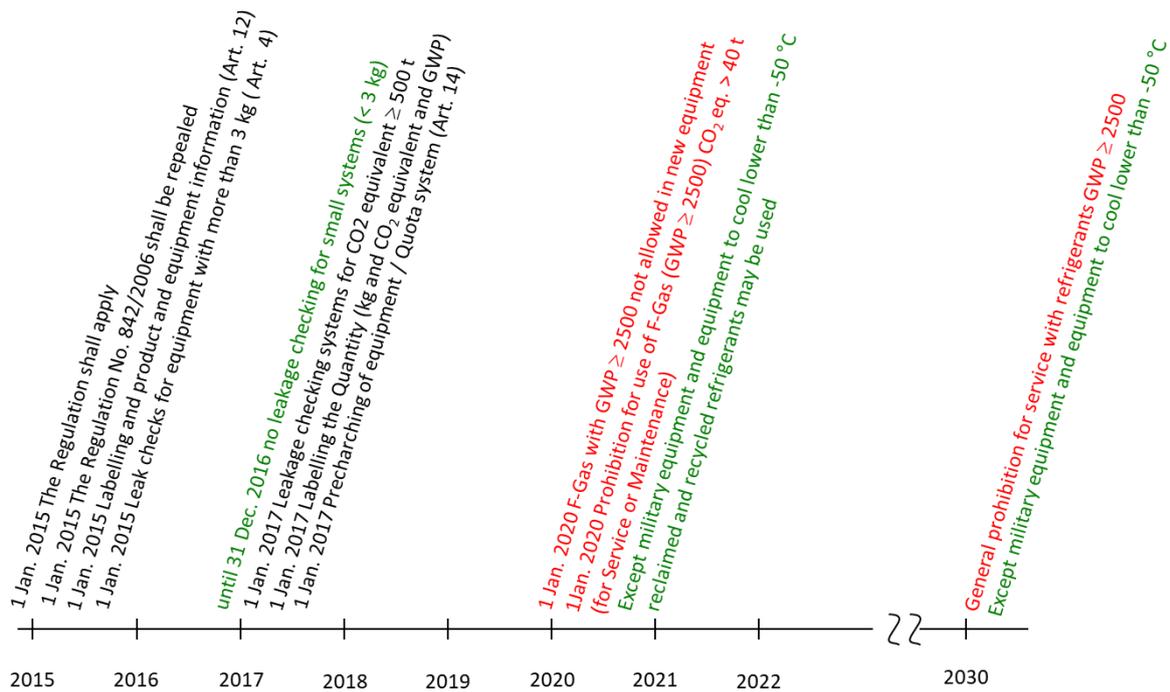
4. What relevance does the GWP value have?

To determine the harmfulness of refrigerants, they are compared to the greenhouse gas CO₂. The resulting value, which is referred to as GWP (Global Warming Potential), indicates the factor by which the substance's potential effect on global warming is higher than that of CO₂. This is referred to as the CO₂ equivalent.

For example: R-404A has a GWP of $\approx 3,900$, i. e. one kilogram of R-404A that is released into the atmosphere has the equivalent harmful effect of $\approx 3,900$ kg CO₂.

¹ Article 1 Chapter 1 of Regulation (EU) No 517/2014 of the European Parliament and the Council of 16 April 2014.

5. From which date onwards will the Regulation affect operators?



As of 1 January 2017:

All new and existing systems are subject to the amended regulations for leakage tests. Depending on the CO₂ equivalent of the respective refrigerant, leakage tests may be mandatory with immediate effect – even in the case of smaller fill quantities. The following table shows the limits above which leakage tests will be mandatory in the future:

Refrigerant	GWP	Maximum amount of refrigerant in the system without mandatory leakage test
R134a	1430	3,5 kg
R-449A	1397	3,58 kg
R-452A	2141	2,34 kg
R-404A	3920	1,28 kg
R-507	3990	1,25 kg
R-23	14800	0,34 kg
R-469A	1357	3,6 kg
WT77	1516	3,4 kg

All new and existing systems with refrigerant volumes above the forenamed limits must be tested for leak tightness at regular intervals.

As of 1 January 2020:

Refrigerants in **new systems** may not exceed a GWP of 2,500. Regulation (EU) No 517/2014 does not specify any limits regarding the fill quantity. Devices and systems that generate test chamber temperatures below -50 °C are exempted; these systems generally use the refrigerant R-23 which is not covered by the Regulation.

Existing systems may continue to operate after 2020, irrespective of the refrigerant used. The exception are systems that use R-404A in a fill quantity above 10 kg: When serviced, they must be refilled with recycled R-404A.

Until 31 Dec. 2030:

Existing systems, using 10 kg or less of refrigerant R-404A may be refilled with fresh, i.e. new R-404A when they are serviced.

As of 1 January 2030:

Existing systems must be changed over to an alternative refrigerant when they are serviced.

6. Does the operator have to pass additional leakage tests?

As explained under 5, all systems that exceed a certain fill quantity are affected. Operators are responsible for commissioning and/or performing the leakage test. Depending on the refrigerant quantity, the test cycle may range between 3 and 12 months. Where automatic leakage systems are used, the intervals are twice as long. Leak tightness tests must be carried out at or above the following refrigerant quantities:

Fill quantity (CO ₂ equivalent)	Without automated leakage detection	With automated leakage detection
5 t to 50 t (R404A 1.25 kg to 12.5 kg) (R23 0.33 kg to 3.3 kg)	every 12 months	every 24 months
50 t to 500 t (R404A 1.25 kg to 12.5 kg) (R23 0.33 kg to 3.3 kg)	every 6 months	every 12 months
> 500 t (R404A > 125 kg) (R23 > 33 kg)	every 3 months	every 6 months

7. Can automatic leakage monitoring help?

Leakage monitoring of cooling devices prevents undetected effluence of refrigerants and indicates leakages at an early stage. On principle, the installation of leakage monitoring systems does not replace leakage tests. However, the prescribed test cycle can be extended to twice its length.

8. What other formal consequences are there for operators?

Operators of refrigeration systems are required to have a comprehensive chain of evidence for the quantity of purchased refrigerant and its use. This comprises the duty to hold evidence and documentation regarding the entire life cycle of the system. One way of ensuring such documentation is the **weisstechnik** logbook which we provide free of charge.

REFRIGERANTS BY WEISSTECHNIK

1. How much refrigerant is used in **weisstechnik** systems?

New systems and systems produced after January 1st 2016: The refrigerant quantity, the GWP and the CO₂ equivalent are all specified in the technical documentation of the respective system. Please do not hesitate to ask your contact at **weisstechnik** for further information regarding the refrigerant quantity.

Information regarding the refrigerant values is also specified on the system's identification plate:

Typ Type	<input type="text"/>			Baujahr Year of Constr.	<input type="text"/>	
Geräte-Nr. Serial No.	<input type="text"/>			Gewicht Weight	<input type="text"/>	
Kältemittel Refrigerant	Menge Quantity	GWP 100 GWP 100	CO ₂ -Äquiv. CO ₂ -Equiv.	ND max. LP max.	HD max. HP max.	Standdruck Const. pressure
R404A	10,00 kg	3.920	39,20 t	1		
R23	4,50 kg	14.800	66,60 t	2		
R404A	2,00 kg	3.920	7,84 t	3		
Nennstrom Nom. Current	Nennleistung Nom. Output		Spannung Voltage			
Zusatzinformation Additional info			<input type="text"/>			Made in Germany
Erhält fluoridierte Treibhausgase. Contains fluorinated greenhouse gases.						

The system shown here has a refrigeration system which is composed of 3 parts. Since no CO₂ equivalent smaller than 5 tons has been installed in any of the circuits, all 3 circuits must be tested for leaks. Due to the capacity of the ultra-low temperature circuit (R-23) and the resulting CO₂ equivalent of >50 t, a leakage test needs be carried out for this circuit every 6-months. The other two circuits fall below the 50 t limit and must therefore only be checked annually.

Existing systems and systems produced before January 1st 2016: Information regarding the refrigerant quantity is specified on the system's identification plate:

Typ / Auftrag Type / Order	<input type="text"/>						
Geräte-Nr. Serial No.	<input type="text"/>		Baujahr Year of construction	<input type="text"/>			
Kältemittel Refrigerant	R-404A	1 kg	1	ND max. LP max.	bar g	HD max. HP max.	25 bar g
Kältemittel Refrigerant	R-23	0,25 kg	2	ND max. LP max.	bar g	HD max. HP max.	25 bar g
Systemplan Nr. System Orag. No.	<input type="text"/>		Standdruck Constant pressure	<input type="text"/>			
Spannung Voltage	<input type="text"/>		Nennleistung Nominal output	<input type="text"/>			
Schaltplan Wiring Diag. No.	<input type="text"/>		Nennstrom Nominal current	<input type="text"/>			
	<input type="text"/>		Made in Germany				
Enthält vom Kyoto-Protokoll erfasste fluorierte Treibhausgase Contains fluorinated greenhouse gases covered by the Kyoto Protocol							CE

The cooling circuits are listed separately here. In this example, there are two circuits, one for pre-cooling (R-404A) and one for deep-temperature cooling (R-23). The CO₂-equivalents are calculated:

Pre-cooling (R-404A):
$$m_{CO_2,VK} = GWP_{R404A} \times m_{R404A} = 3920 \times 1 \text{ kg} = 3920 \text{ kg}$$

Low-temp-cooling (R-23):
$$m_{CO_2,TK} = GWP_{R23} \times m_{R23} = 14800 \times 0,25 \text{ kg} = 3700 \text{ kg}$$

In the above example, therefore, both refrigeration circuits would be below the 5 t limit set out in Regulation (EU) No 517/2014. The device would thus be subjected to no cyclic leakage test. However, since both refrigeration circuits are considered separately, it may happen that, although the pre-cooling stage is below the limit of 5 t, the deep-freezing stage is not. In this case, a cyclic leakage test for the deep-freeze cycle according to the pattern described above is required.

The refrigerant amounts are also listed in the system's technical documentation which was included at the time of delivery. If the technical documentation is not available anymore, please request a copy from your contact at **weisstechnik**.

2. Our alternatives to R-404A:

a. Existing systems: R-452A (GWP of 2,141):

R-452A was developed as an alternative for low temperature applications and is below the required GWP limit. Its thermodynamic properties largely correspond to R-404A. For all **weisstechnik** systems, R-452A is suitable as a direct replacement (so-called drop-in).

Similar to R-404A, R-452A is neither flammable nor toxic. Changes in the safety assessment are thus not necessary either for existing or for new systems.

b. **New systems including and after ClimeEvent: R-449A (GWP 1,397):**

Its very low GWP makes R-449A the first choice as substitute refrigerant in **weisstechnik**'s forward-looking strategy. However, since the thermodynamic performance figures deviate from R-404A, adjustments of the refrigeration technology are necessary to guarantee the systems' extensive performance range. The use of R-449A is thus expedient in new systems only.

Again, R-449A is neither flammable nor toxic. Changes in the safety review are thus not necessary either for existing or for new systems.

3. **Our alternatives for R-23:**

a. **Existing plants: WT77 (GWP 1516):**

weisstechnik has developed WT77 as a direct replacement ("drop-in") for R-23 itself. It is used in cascade systems of environmental simulation equipment from **weisstechnik** down to -70°C. Retrofitting of equipment and systems is particularly worthwhile in the event of repairs. R-23 and WT77 are often replaced one-to-one. In almost all cases, no hardware changes are necessary for the conversion of units built in 2005 or later. WT77 is neither flammable nor toxic. Accordingly, no changes in safety considerations are necessary for existing or new equipment. A safety data sheet is available.

b. **New systems as of ClimeEvent year of construction 2018/19: R-469A (GWP 1357):**

weisstechnik has developed R-469A itself as a replacement for R-23. It is freely available and is mainly used in ultra-low temperature applications down to -70°C. R-469A is used in almost all new temperature and climate test chambers from **weisstechnik**. It is neither flammable nor toxic and achieves nearly the same performance characteristics as R-23, often outperforming it in the typical temperature range down to -55°C. The use of R-469A in existing systems only makes sense with modification of the refrigeration technology and control system. At the express request of the customer, the new refrigeration system from **weisstechnik** also works with R-23 without conversion, but R-469A is preferred because of its significantly lower GWP.

4. **Do the alternative refrigerants have any disadvantages?**

Due to their low market spread, alternative refrigerants currently have a higher purchase price. However, in the course of the Europe-wide conversion to the new refrigerants, prices will assimilate.

The performance parameters of the new alternative refrigerants are different from R-404A. To meet the high performance requirements of our systems, adjustments of the refrigeration technology are necessary. These adjustments have been tested in great detail over the last few years, both in internal and in field tests. There will be no loss of performance.

The new alternative refrigerants meet the published performance parameters of the **weisstechnik** systems.